3.2.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of Hanford are shown in Table 3.2.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to Hanford operations.

Table 3.2.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Hanford Site Operation

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic and cosmogenic radiation	30
External terrestrial radiation	30
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	365

[a] HF PNL 1994b.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from Hanford operations provide another source of radiation exposure to individuals in the vicinity of Hanford. Types and quantities of radionuclides released from Hanford operations in 1993 are listed in the *Hanford Site Environmental Report for Calendar Year 1993* (PNL-9823). Doses to the public resulting from these releases are presented in Table 3.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment's (No Action) radiological releases and resulting impacts for the year 2005 (Section 4.2.1.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from Hanford operations in 1993 is approximately 1.6×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of Hanford operations is less than 2 chances in 100 million. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 1.8×10^{-4} excess fatal cancers are projected in the population living within 80 km (50 mi) of Hanford from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based upon this mortality rate, the number of fatal cancers expected during 1993 in the population living within 80 km (50 mi) of Hanford was 760. This number of expected fatal cancers is much higher than the estimated 1.8×10^{-4} fatal cancers that could result from Hanford operations in 1993.

Table 3.2.9–2. Radiation Doses to the Public From Normal Hanford Site Operation in 1993 (Committed Effective Dose Equivalent)

	Atmospheric Releases[a]		Liquid Releases		Total	
Members of the General Public	**Standard[b]**	**Actual**	**Standard[b]**	**Actual[c]**	**Standard[b]**	**Actual**
Maximally exposed individual (mrem)	10	0.020	4	0.012	100	0.032
Population within 80 km[d] (person-rem)	None	0.25	None	0.11	100	0.36
Average individual within 80 km[e] (mrem)	None	6.6×10^{-4}	None	2.9×10^{-4}	None	9.5×10^{-4}

[a] Includes direct radiation dose from surface deposits of radioactive material.

[b] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (see 58 FR 16268). If the potential total dose exceeds the value, it is required that the contractor operating the facility notify DOE.

[c] The actual dose value given in the column under Liquid Releases conservatively includes all water pathways, not just the drinking water pathway.

[d] In 1993, this population was approximately 380,000.

[e] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Source: HF PNL 1994b.

Hanford workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in the facilities. Table 3.2.9–3 presents the average worker, maximally exposed worker, and total cumulative worker dose to Hanford workers from operations in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to Hanford workers from normal operations in 1992 is projected to be 0.10.

Table 3.2.9–3. Radiation Doses to Workers From Normal Hanford Site Operation in 1992 (Committed Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average worker (mrem)	ALARA	27.3
Maximally exposed worker (mrem)	5,000	3,000
Total workers[b] (person-rem)	ALARA	258

[a] DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[b] The number of badged workers in 1992 was approximately 9,470.

Source: 10 CFR 835; DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Hanford Site Environmental Report for Calendar Year 1993* (PNL-9823). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in that document.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain

hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface water during swimming, soil through direct contact, or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are presented in Section 3.2.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements) contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and through inspection of mitigation measures. Health impacts to the public may occur during normal operations at Hanford via inhalation of air containing hazardous chemicals released to the atmosphere by Hanford operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to Hanford workers during normal operations may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Hanford workers are also protected by adherence to Occupational Safety and Health Administration (OSHA) and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, worker health conditions at Hanford are expected to be substantially better than required by standards.

Health Effects Studies. Three epidemiological studies and a feasibility study have been conducted on communities around Hanford to determine if there are any excess cancers in the general population. One study found no excess cancers but identified an elevated rate of neural tube defects in progeny. This elevated rate was not attributed to parental employment at Hanford. A second study suggested that neural tube defects were associated with cumulative radiation exposure and also showed other defects that statistically were associated with employment at Hanford, but not with parental radiation exposure. The third study did not show any cancer risk associated with living near the facility.

Many epidemiologic studies have been carried out on the Hanford workers, including updated cohort analyses over the years. The studies have consistently shown a statistically significant elevated risk of death from multiple myeloma among Hanford male workers associated with radiation exposure. The excess was observed only among workers exposed to 10 radiation absorbed doses (rads) or more. Other studies have also identified an elevated risk of death from pancreatic cancers, but the elevated risk disappeared in a recent re-analysis of the updated cohort. Among Hanford female workers, studies have reported an elevated risk of deaths from musculoskeletal and connective tissue systems.

A more detailed description of the studies reviewed and the findings is found in Section M.4.2.

[Text deleted.]

Accident History. There have been 127 nuclear-process-related incidents with some degree of safety significance at Hanford over its period of operation. These do not include less-significant instances of radioactivity release or contamination during normal operations, which have been the subject of other reviews. The 127 incidents fall into 3 significant categories, based on the seriousness of the actual or potential consequences.

Fourteen of the incidents were Category 1, indicating that serious injury, radiation release or exposure above limits, substantial actual plant damage, or a significant challenge to safety resulted. Forty-six events were Category 2, less severe than Category 1, but involving significant cost or a less significant threat to safety. The remaining 67 incidents were Category 3, causing minor radiation exposure or monetary cost, or involving a violation of operating standards without a serious threat to safety (HF 1993a:1). [Text deleted.]

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

Accordingly, DOE RL has developed and maintains a comprehensive set of emergency preparedness plans and procedures for Hanford to support onsite and offsite emergency management actions in the event of an accident. The DOE RL also provides technical assistance to other Federal agencies and to State and local governments. Hanford contractors are responsible for ensuring that emergency plans and procedures are prepared and maintained for all facilities, operations, and activities under their jurisdiction, and for directing implementation of those plans and procedures during emergency conditions. The DOE RL, contractor, and the State and local government plans are fully coordinated and integrated. Emergency control centers have been established by the DOE RL and its contractors for the principal work areas to provide oversight and support to emergency response actions within those areas.